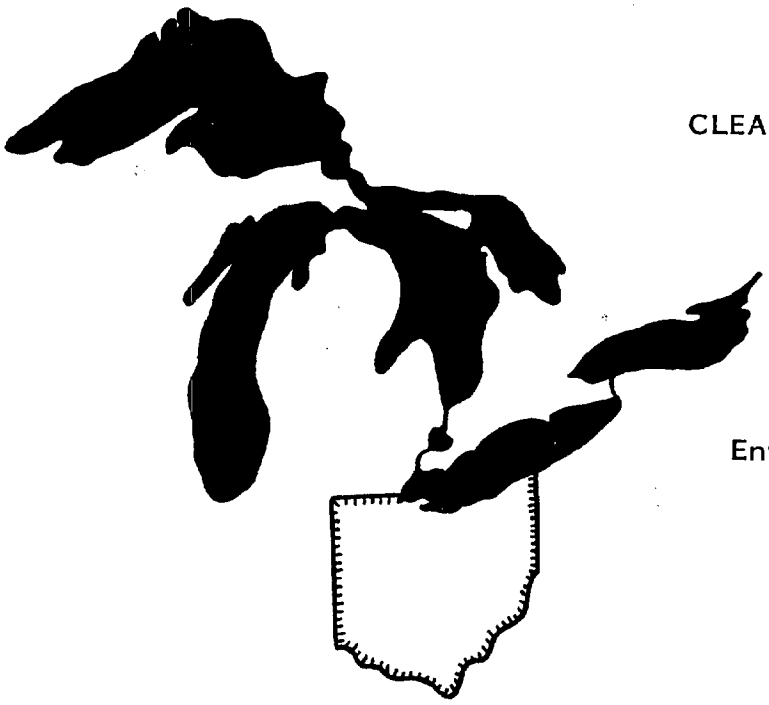

CLEAR TECHNICAL REPORT NO. 287

Environmental Sensitivity Index (ESI) Maps for the Lake Erie System

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TABLE OF CONTENTS

	Page
List of Tables	3
List of Figures	3
Introduction	4
Methods	6
Geomorphology	6
Biology	11
Socio-Economic Features	14
Literature Cited	15
Potential Reviewers	16
Tables	17
Figures	22

List of Tables

1. Environmental Sensitivity Index Species Listing..... 17

List of Figures

1. Lake Erie-Lake St. Clair Overview..... 22

2. Michigan Topographic Maps (7.5 minute)..... 23

3. Ohio Topographic Maps (7.5 minute)..... 24

4. Pennyslyvania Topographic Maps (7.5 minute)..... 25

5. New York Topographic Maps (7.5 minute)..... 26

6. Ontario Topographic Maps (7.5 minute)..... 27

DEVELOPMENT OF ENVIRONMENTAL SENSITIVITY INDEX (ESI) MAPS FOR THE LAKE ERIE SYSTEM

Introduction

The need for Environmental Sensitivity Index (ESI) mapping was initiated in Alaska in response to pipeline activity at the Lower Cook Inlet (Hayes et al. 1976). Since the initial study in the early 1970's NOAA has funded 16 projects along the sea coasts of the United States. The initial Environmental Sensitivity Index maps consisted of a set of 10 maps, each indicating a unique set of data, i.e. bathymetry, geomorphology, wildlife, socio-economic areas, etc. The ESI maps have evolved to the stage where scientific interpretation of geomorphic, biologic, socio-economic and spill response equipment locations are presented in detailed scale in one 7 1/2 minute topographic map. This allows field personnel involved in decision-making and spill clean-up to observe all the significant variables at one time.

The rationale for researching and producing Environmental Sensitivity Index Maps for Lake Erie stems from the increased production of oil and toxic substances around the Great Lakes, as well as oil discharges from commerical vessels and discharges from oil refineries and re-refineries. As of November 1982, there are 15 oil refineries currently discharging effluents directly into the Great Lakes, 8 of which are found from Port Huron, Michigan/Sarnia, Ontario (at the Southern end of Lake Huron) to Buffalo, New York. Three of these refineries are in the United States (2 in Toledo and one in Lima, Ohio) and the other 5 lie in the Canadian region (2 in Sarnia, 2 in Corunna and 1 in Nanticoke). Other refineries lie within the Great Lakes drainage basin but their effluents are incorporated into municipal treatment plants. Of these 8 refineries, all (with the exception of the Nanticoke plant) have been designated as Class A Areas of Concern (Petroleum Refinery Point Source Task Force, 1982), due to severe impairment of a beneficial use of the Great Lakes' water. This judgment was based on water quality data from these plants with parameter values that exceeded either the Great Lakes Water Quality Agreement or a jurisdictional standard. Although the three major commodities shipped within the Great Lakes are grain, coal and iron ore, the balance of the minor bulk commodities include petroleum products such as fuel oil, gasoline, heating oils and bunker fuels and are shipped from refineries in Montreal and overseas to ports in Ontario and the United States (Environment Canada, 1980). Another source of potential spills comes from the numerous oil wells adjacent to the basin. The state of Ohio, for example, although it does not allow drilling for oil in Lake Erie, does permit natural gas wells. Oil drilling is also permitted in Lake Erie streams and on lands 300 ft. distant from the Lake Erie shoreline (Gordon, 1983).

Thirty-four hydrocarbon spills to Lake Erie were reported to the Ohio Environmental Protection Agency's Emergency Response Team for the period beginning January 1, 1978 and ending March 30, 1983 (Fowler, 1983). This 63-month period had an average of 0.54 hydrocarbon spills

per month or one spill every two months. However, data provided by the U. S. Coast Guard for the area from Vermilion to Conneaut, Ohio claimed 275 hydrocarbon spills and 19 hazardous substances spills for the 1978-1981 period. The 294 spills reported over the 48-month period gives an average of 6.1 spills per month. The majority of the spills (263) ranged from one to 1,000 gallons with 13 spills exceeding 1,000 gallons. The area of most frequent spill occurrence is the Cuyahoga River.

Any chemical spills within the Great Lakes are of considerable importance due to the retention time of water within the basin:

	Average Time in Years (1)
Lake Superior	191.0
Lake Michigan	99.1
Lake Huron	22.6
Lake St. Clair	----
Lake Erie - western*	0.2
Lake Erie - central*	1.4
Lake Erie - eastern*	0.8
Lake Ontario	6.0
TOTAL	321.1

*Data from Burns, 1976 (Vol. 33, pg. 523)

(1) Great Lakes Basin Commission, 1979. Data from Great Lakes Notebook, Fourth Coast Facts and Issues.

An overview of the Lake Erie system is presented in Figure 1. Figures 2 thru 5 depict the topographic maps prepared utilizing the Environmental System Index for the states of Michigan, Ohio, Pennyslvania and New York, respectively. Figure 6 shows the Canadian topographic maps available for the Lake Erie system. These areas adjacent to Lake Erie and Lake St. Clair are presently being evaluated by the Canadians for oil spill response prioritization.

Methods

Geomorphology

Considerable modification of the existing 10-point geomorphic classification system was required due to the uniqueness and variability within the Great Lakes Basin. The following list presents a classification system for the Great Lakes based on mappable shoreline types and sensitivity judgments:

1. Exposed Bedrock Bluffs
2. Exposed Unconsolidated Sediment Bluffs
3. Shelving Bedrock Shores
4. Sand Shores
5. Mixed Sand and Gravel Shores
6. Gravel Shores
7. Rip-Rap and Harbor Structures (solid=rip rap, dashed=vertical wall
8. Sheltered Bluffs
9. Low Banks
10. Coastal Wetlands

The categories range from least sensitive (Category 1, Exposed Bedrock Bluffs) to the most sensitive (Category 10, Coastal Wetlands). Descriptions of these classifications are presented below:

1. Exposed Bedrock Bluffs

This classification includes vertical or near vertical bedrock bluffs from 10 to 200 feet in height. In the Lake Erie system this includes gray limestone and dolomite cliffs in the islands region of the western basin, black and gray shale bluffs in the central basin from Vermilion to Cleveland, a brown sandstone cliff at Vermilion-on-the-Lake, gray and black shale in the eastern basin between Erie and Buffalo, gray dolomite and black shale cataracts and cliffs between Niagara Falls and the Niagara Escarpment, and red shale cliffs along the lower Niagara River. The bedrock shores are generally resistant to erosion and contribute little in the way of beach-building material. Landside access to the base of these bluffs is difficult at most locations. Beaches rarely occur in front of the bedrock cliffs, except where streams have cut small ravines or in coves between two headlands. On the sensitivity maps, this classification is shown in black.

2. Exposed Unconsolidated Sediment Bluffs

This classification includes vertical or steeply sloping bluffs of unconsolidated material ranging in height from 10 to 150 feet. In the Lake Erie system, this includes glacial till and lacustrine sediments. The till is generally the lower unit when the two occur together and its bluffs are often more nearly vertical. It is a gray mixture of compact silt, clay, sand and gravel with the finer particles predominating. Lacustrine bluffs are composed of brown, lake-deposited

silt and fine sand. This material is not as compact and is permeable to ground water; it erodes more easily. The shoreline of the central basin from Cleveland to Erie is dominated by a combination of these two bluff types. Because of their unconsolidated nature, till and lake deposit bluffs are among the most readily eroded shorelines on Lake Erie. Approximately 20% of the material eroded contributes sand and gravel to the littoral beaches. Like the bedrock areas, landside access to the base of these bluffs is difficult at most locations. Deep, "V" shaped ravines have been cut into these cliffs every few miles which afford some access routes. Beaches are normally narrow (<50 feet) and in many areas absent in front of till or lake sediment bluffs, except at stream mouths where widths approach 100 feet. On the sensitivity maps, this classification is shown in gray.

3. Shelving Bedrock Shores

This classification includes gently sloping bedrock surfaces that extend from the nearshore lake bottom to heights of up to 10 feet above lake level. In the Lake Erie system this includes the gray limestone and dolomites on the east shores of most of the western basin islands and the Marblehead Peninsula and black or gray shale in the central and eastern basins. In the islands region, this exposure is normally a "dip-slope" of the bedrock and commonly contains glacial grooves. The width of these shores range from less than 10 feet to over 100 feet. During the months of May through October, dense mats of the filamentous alga, Cladophora glomerata grow on the rock surfaces from the water down to a depth of approximately 10 feet. Because of the gentle slope and hard surface of this type of shore, access is usually good. Beaches rarely occur in front of the bedrock except in small coves where beach material is generally gravel. On the sensitivity maps, this classification is shown in brown.

4. Sand Shores

This classification includes granular shores ranging in size from very fine sand to very coarse sand (0.1 to 2.0 mm in diameter). In the Lake Erie system, sand beaches are generally narrow to moderate in width (50-200 feet), except at deltas, sand spits and on the updrift sides of large shore structure where wide beaches are found. Notable accumulations of sand occur at the delta of the St. Clair River, north of Monroe harbor at Sterling State Park, Woodtick Peninsula spit on the northwest side of Maumee Bay, Cedar Point and Bay Point spits at the entrance to Sandusky Bay, Headlands State Park west of Fairport Harbor, Walnut Beach west of Ashtabula harbor, Presque Isle spit surrounding Erie Harbor and the beaches of Hanford, Sunset, Lotus, Grandview, and Evans bays between Dunkirk and Buffalo. Elsewhere, beaches are generally absent fronting bedrock areas, except at stream mouths and in small coves, or are relatively narrow at the base of unconsolidated bluffs. Because of the gentle slope of most of the larger beaches, small changes in water level can result in major changes in beach width; the narrower beaches are normally steeper and therefore show

less change with water level fluctuations. Access to the large accumulations are generally good, however landside approaches to the small beaches fronting high bluffs are difficult. On the sensitivity maps, this classification is shown in blue.

5. Mixed Sand and Gravel Shores

This classification includes shorelines composed of sand, gravel and shell mixtures which normally form narrow (<50 feet) to moderate (<100 feet) width beaches. The slope of the shoreline is generally greater than that for sand beaches but not as steep as that for gravel. These beaches are not widespread, but they often occur at the high, wave-energy end of sandy shores or in coves between headlands. Access to these beaches is normally good for those associated with larger sandy beaches and poor for those in isolated coves. On the sensitivity maps, this classification is shown in green.

6. Gravel Shores

This classification includes granular shores ranging in size from pebbles to boulders (2 to 4000 mm in diameter). In the Lake Erie system, gravel beaches are generally narrow (<50 feet) and are usually associated with bedrock exposures. The most notable gravel beaches occur on Marblehead peninsula and the islands of the western basin. The most common component is pebble to cobble-sized gravel derived from the limestone and dolomite cliffs. Isolated gravel beaches also occur in the central and eastern basins at the base of shale and glacial till cliffs, particularly in small coves. These beaches are typically composed of shale "shingle" and crystalline erratics from the glacial deposits. Landside access to gravel beaches is generally difficult because of the high, steep nature of the surrounding bluffs. In areas of shelving bedrock, access is normally good. On the sensitivity maps, this classification is shown in turquoise.

7. Rip-rap and Harbor Structures

This classification includes several types of man-placed material for shore protection and navigation. The variety of material used includes steel sheeting, large concrete blocks, wood, extraneous metallic and concrete debris and tires. A large portion of the St. Clair, Detroit, and Niagara Rivers are reinforced by some type of added structure. The bluff areas between Cleveland and Erie are subject to intensive erosion and these areas have been covered by rip-rap materials.

Other types of man-made structures along the lake are dredge disposal areas (a combination of both steel sheeting and concrete block) and wetlands maintained by earthen and rock covered dikes (i.e. Sandusky Bay).

The fauna and flora associated with this classification is also variable depending on the type of material utilized in the structure and the accessibility to the splash zone. Some of the structures provide fishery habitat and bird nesting sites. Harbor structures create a sheltered effect causing debris and oil to accumulate in slack water areas.

Solid lines indicate rip-rap and rubble mound structures. A dashed line indicates vertical walled structures (steel sheet piling and poured concrete) which do not have extensive internal cavities). See Figure 5-B for an illustration of steel sheet piling groin at Crane Creek State Park. This classification is displayed on the sensitivity maps in purple.

8. Sheltered Bluffs

This classification includes vertical or steeply sloping bluffs of bedrock or unconsolidated deposits which are not exposed to open lake conditions or torrent stream flow. These bluffs can range in height from 5 to 150 feet and are often dissected by tributary ravines. In the Lake Erie systems, sheltered bluffs occur along the St. Clair River, Anchor Bay of Lake St. Clair, Detroit River, Maumee Bay, Sandusky Bay, Presque Isle Bay, upper Niagara River, and the navigable portions of the major tributaries. Narrow sand and/or gravel beaches and wetlands are often associated with the edge of these bluffs. These shores are commonly developed for residential and commercial use. Because of this development, landside access is normally good. Natural areas are less accessible. On the sensitivity maps, this classification is shown in yellow.

9. Low Banks

This classification includes low banks (<5 feet) of unconsolidated sediments (i.e. glacial till, lacustrine deposits, and stream alluvium) which are subject to frequent lake or stream flooding. Because of the longitudinal seiche activity which is typical of Lake Erie, areas subject to flooding are concentrated at the western and eastern extremities of the lake. Also, the lower reaches of most tributaries have a "drowned month" forming estuarine conditions where flooding from either the lake or the tributary can occur. These low shorelines are also associated with mud flats, sand bars, and wetlands. Because of the low nature of this type of shoreline, landside access is normally good, but can be hampered by the soft or marshy nature of the shore material. Shore erosion in these areas can be extreme during high water storms. On the sensitivity maps, this classification is shown in orange.

10. Coastal Wetlands

This classification includes shore areas with dense growths of primarily emergent or floating aquatic vegetation. The types of wetlands found in the Lake Erie system include the delta wetlands of the St. Clair River mouth, fringing wetlands which require sheltered shorelines such as those of Lake St. Clair and Buckhorn and Strawberry Islands in the upper Niagara River, coastal lagoon wetlands typified by those associated with Woodtick Peninsula and Presque Isle spits, diked wetlands of the Ohio and Michigan shores of the western basin and the upper reaches of Sandusky Bay, and estuarine wetlands which are prominant in the lower courses of several tributaries such as the Maumee River, Old Woman Creek, Mentor Marsh, and Arcola Creek. Coastal wetlands can vary from a few acre plot in sheltered backwater areas within harbors to over 8000 acres for the St. Clair River delta. Landside access to coastal wetlands is normally good for inshore portions, however offshore growths can be difficult to reach because of the lack of suitable foundation for the movement of heavy equipment. On the maps, this classification is shown in red.

Biology

The rationale for presenting biological data on the ESI maps is to inform the Clean-up team of areas of biological concern due to their status as:

1. Federally endangered species
2. State endangered, threatened and rare species
3. Commercially significant species
4. Species particularly sensitive to oil spills

Primarily the information presented was supplied through the various state agencies under the direction of the Natural Heritage Program.

Michigan Natural Features Inventory
Mason Building, 5th Floor
Box 30028
Lansing, Michigan 48909
517 - 373-1552

New York Natural Heritage Program
50 Wolf Road, Room 528
Albany, New York 12233
518 - 457-5410

New York Significant Habitats
518 - 439-7486

Ohio Natural Heritage Program
Ohio Department of Natural Resources
Fountain Square, Building F
Columbus, Ohio 43224
614 - 265-6453

Western Pennsylvania Conservancy
316 Fourth Avenue
Pittsburgh, Pennsylvania 15282
412 - 288-2777

Data for the spawning and nursery areas of the "commercially significant" fish species were obtained from Goodyear et al. (1982).

Fish stocking information was received from the individual states and is plotted as specifically as possible according to the data supplied. This information represents the general recommended stocking program. There is no certainty that all the streams indicated will be stocked every year. For additional information or specific yearly stocking information contact:

Michigan	Bill McClay	517-373-1280
New York	Floyd Cornelius	716-366-0228
Ohio	Clayton Lakes	614-548-7723
Pennsylvania	Dick Snyder	814-359-5177

The gathered data is presented in the ESI standardized format. The following description should be read only by those people unfamiliar with the system.

The entries are all color coded by phylum:

yellow	mammals
blue	fish
green	birds
turquoise	attached plants and plant communities
red	reptiles and amphibians
orange	mollusks

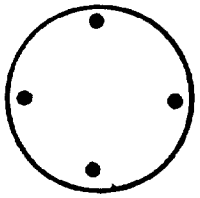
The number in the center of the circle represents an individual species whose name can be discerned by checking the existing ESI master list (Table 1). Species names have been added to the master list because they comply with one or more of the criteria mentioned earlier in the test.

Endangered species (either on the federal or state level) are indicated graphically by a solid red band on the right side of the species record.

An individual's season(s) of sensitivity to oil or hazardous waste spills is indicated by dots along the inside border of the symbol. Sensitivity was determined in 2 ways: 1. depending on a species utilization of niche habitat likely to be affected by spills and 2. determined by a species likelihood of being affected due to spills occurring during spawning or breeding periods. For example, mollusks were considered to be sensitive throughout the year due to their potential exposure and lack of mobility. The Lake Whitefish is considered to be sensitive in the late fall and winter because it spawns during this time.

Summer (June, July, August)

Spring (March, April May)



Fall (September, October November)

Winter (December, January, February)

Finally, individual records are given a location determined as follows:

Point locality ⟶

Range ——|

Area 

Socio-economic Features

The following items of interest have been plotted:

Water Intakes	
Marinas	M
Residential Marinas	RM
Boat Ramps	R
Hoists	H
Floating Tire Breakwalls	FTB
Parks	P
Refuges, Preserves	
Submerged Vegetation	SV
Public Beaches	B

The data was gathered from the US Army Corps of Engineers (1979), Great Lakes '83 Waterway Guide and the most recent edition of NOAA lake navigation charts. Verification of the socio-economic and geomorphometeric features were made during an aerial reconnaissance survey in August 1983.

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Wooldridge, J. (ed.) 1983. Waterway Guide. Great Lakes Edition. Boating Industry Magazine 36(4), 352 p.

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614 - 265-6453

TABLE 1
Environmental Sensitivity Index Species Listing

ESI Master List No.	Common Name	Scientific Name
	MOLLUSK	
72	Northern riffle shell mussel	Epioblasma rangiana
73	Unnamed mussel	Villosa fabilis
74	Unnamed mussel	Obovaria subrotundra
75	Purple warty-back mussel	Cyclonaias tuberculata
76	Simpson's shell/ salamander mussel	Simpsoniconcha ambigua
77	Snuffbox mussel	Dysnomia triquetra
78	White cat's paw pearly mussel	Eploblasma obliquata perobliqua
79	Unnamed mussel	Lampsilis fasciola
80	Eastern sand shell	Ligumia nasuta
81	Knob shell	Obliquaria reflexa
82	Fawn foot	Truncilla donaciformis
83	Deer toe	Truncilla truncata
84	Ridged pocket book	Lampsilis ovata
85	Common elephant ear	Elliptio crassidens
	REPTILES	
9	Eastern fox snake	Elaphe vulpina gloydi
10	Spotted turtle	Clemmys guttata
11	Blanding's turtle	Emydoidea blandingi
--	Kirtland's snake	Clonophis kirtlandi
12	Eastern massacauga	Sistrurus catenatus
16	Lake Erie water snake	Nerodia sipedon insularum
17	Timber rattlesnake	Crotalus horridus
	AMPHIBIANS	
13	Blue-spotted salamander	Ambystoma laterale
14	Tiger salamander	Ambystoma tigrinum
15	Four-toed salamander	Hemidactylium sculatum

FISHES

113	Lake sturgeon	Acipenser fulvescens
114	Northern Madtom	Noturus stigmosus
115	Northern Pike	Esoc lucius
116	Carp	Cyprinus carpio
117	Channel catfish	Ictalurus punctatus
118	White bass	Morone chrysops
119	Yellow perch	Perca flavescens
120	Walleye	Stizostedion v. vitreum
121	Freshwater drum	Aplodinotus grunniens
122	Burbot	Lota lota
123	Eastern sand darter	Ammocrypta pellucida
124	Silver chub	Hybosis storeriana
125	Mooney	Hiodon tergisus
126	Bigmouth buffalo sucker	Ictiobus cyprinellus
127	Channel darter	Percina copelandi
128	Silver lamprey	Ichthyomyzon unicuspis
129	Spotted gar	Lepisosteus oculatus
130	Pugnose minnow	Notropis emiliae
131	Iowa darter	Etheostoma exile
132	Great Lakes muskellunge	Esox m. masquinongy
133	Bigeye chub	Hybopsis amblops
134	Cisco	Coregonus artedii
135	Lake white fish	Coregonus clupeaformis
136	Longnose sucker	Catostomus catostomus
137	Western banded killifish	Fundulus diaphanus menona
138	Longnose dace	Rhinichthys cataractae
139	American brook lamprey	Lampetra appendix
140	River redhorse	Moxostoma carinatum
141	Spoonhead sculpin	Cottus ricei
142	Pugnose shiner	Notropis anogenus
143	Coho salmon-stocking	Oncorhynchus kisutch
144	Steelhead-stocking	
145	Brown Trout-stocking	Salmo trutta
146	Rainbow Trout-stocking	Salmo gairdneri
147	Chinnook salmon-stocking	Oncorhynchus tshawytscha
148	Smallmouth bass	Micropterus dolomieui
149	White perch	Morone americana
150	Sauger	Stizostedion canadense
151	Brook Trout Stocking	Salvelinus fontinalis

MAMMALS

27	Muskrat	Ondatra zibethicus

BIRDS

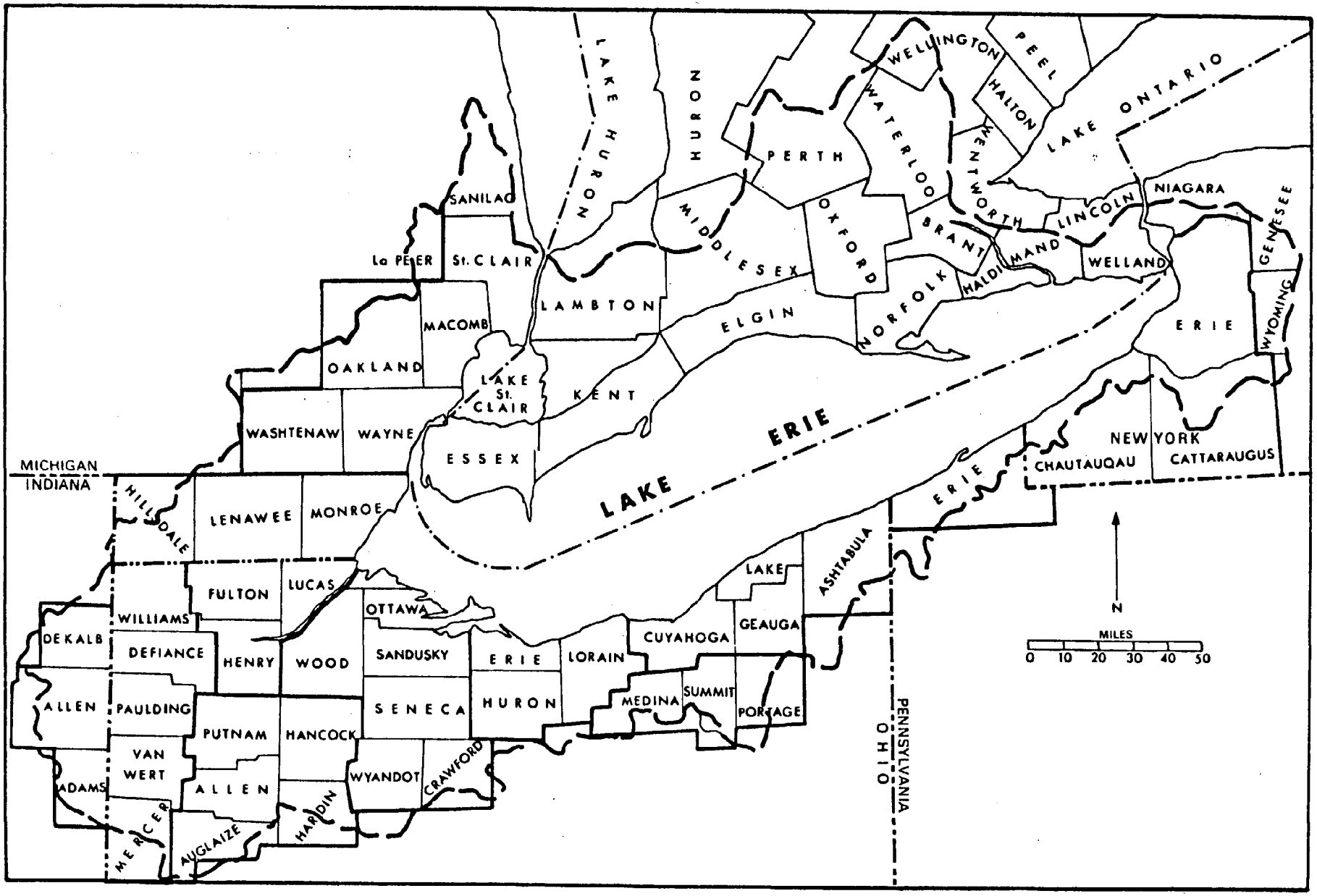
B	Shorebirds	
C	Waterfowl	
D	Diving birds	
E	Wading birds	
F	Seabirds	
38	Herring gull	Larus argentatus
40	Ring-billed gull	Larus delawarensis
42	Bonaparte's gull	Larus philadelphia
45	Common tern	Sterna hirundo
52	Wilson's phalarope	Steganopus tricolor
54	Great blue heron	Ardea herodias
88	Great egret	Casmerodius albus
107	Peregrine falcon	Falco peregrinus
123	Southern bald eagle	Haliaeetus leucocephalus
138	Forster's tern	Sterna fosteri
168	King rail	Rallus elegans
169	Barn owl	Tyto alba
170	Cliff swallow	Hirundo pyrrhonota
171	American bittern	Botauros lentiginosus
172	Marsh wren	Cistothorus palustris
173	Prothonotary warbler	Protonotaria citrea
174	Least bittern	Ixobrychus exilis
175	Henslow's sparrow	Ammodramus henslowii
176	Upland sandpiper	Bartramia longicauda
177	Dick cissel	Spiza americana
178	Sora	Porzana carolina

PLANTS

1	Dotted horsemint	Monarda punctata
2	Beach wormwood	Artemisia caudata
3	Richardson's pordweed	Potomogeton richardsonii
4	American beach grass	Ammophila breviligulata
5	Lesser panicled sedge	Carex diandra
6	Beach - pea	Lathyrus maritimus
7	Leafy tussock sedge	Carex aquatilis
8	Floating pondweed	Potomogeton natans
9	Two-leaved water milfoil	Myriophyllum heterophyllum
10	Bushy cinquefoil	Potentilla paradoxa
11	Striped maple	Acer pensylvanicum
12	Radiate sedge	Carex radiata
13	Closed genitian	Gentiana clausa
14	Wheat sedge	Carex atherodes
15	Wild rice	Zizania aquatica
16	Wapato	Sagittaria cuneata
17	Hazel dodder	Cuscuta coryli
18	Marsh arrow-grass	Triglochin palustre
19	Lake Erie pinkweed	Polygonum pensylvanicun v. englandulosum
20	Bushy knotweed	Polygonum ramosissimum
21	Drummond's rock-cress	Arabis drummondii
22	Harebell	Campanula rotundifolia
23	Northern bog violet	Viola nephrophylla
24	Narrow-leaved summer bluets	Houstonia nigricans
25	Rock sandwort	Arenaria stricta
26	Sprengel's sedge	Carex sprengelii
27	Alpine rush	Juncus alpinoarticulatus
28	Flat-stem pondweed	Potomogeton zosteriformis
29	Filiform pondweed	Potomogeton filiformis
30	Prairie fringed orchid	Platanthera leucophaea
31	Prickly hornwort	Ceratophyllum echinatum
32	Western hairy rock-cress	Arabis hirsuta v. pycnocarpa
33	Water - starwort	Callitriche verna
34	Prairie thimbleweed	Anemone cylindrica
35	Limestone rock-cress	Arabis divaricarpa
36	Bullhead lily	Nuphar variegatum
37	Great Lakes goldenrod	Solidago remota
38	Plains muhlenbergia	Muhlenbergia cuspidata
39	Beach - heather	Hudsonia tomentosa
40	Smith's bulrush	Scirpus smithii
41	Olivaceo is spikerush	Eleocharis olivacea
42	Pursh's bulrush	Scirpus purshianus
43	Little green sedge	Carex viridula
44	Grass-leaf arrowhead	Sagittaria graminea
45	Early buttercup	Ranunculus fasicularis
46	Rock-harlequin	Corydalis sempervirens
47	Balsam popular	Populus balsamifera
48	Snowberry	Symphoricarpos albus v. albus

49	Panic grass	Panicum leibergii
50	Sullivant's milkweed	Asclepias sullivantii
51	Water - willow	Justicia americana
52	Arrowhead	Sagittaria montividensis
53	American lotus	Nelumbo lutea
54	Waxy meadow-rue	Thalictrum revolutum
55	Monkey - flower	Mimulus alatus
56	Smartweed	Polygonum careyi
57	Seedbox	Ludwigia alternifolia
58	White lady-slipper	Cypripedium candidum
59	Cup - plant	Silphium perfoliatum
60	Fire pink	Silene virginica
61	Gromwell	Lithospermum caroliniense
62	Brook lobelia	Lobelia kalmii
63	Northeastern bladderwort	Utricularia resupinata
64	Hoary willow	Salix candida
65	Autumn willow	Salix serissima
66	Whorled nutrush	Scleria verticillata
67	Sartwell's sedge	Carex sartwellii
68	Golden-fruited sedge	Carex aurea
69	Bebb's sedge	Carex bebbii
70	Swamp-pink	Arethusa bulbosa
71	Small bur-reed	Sparganium minimum
72	Yellow vetchling	Lathyrus ochroleucus
73	Leafy goldenrod	Solidago squarrosa
74	Long-stalked sedge	Carex pedunculata
75	Carolina spring-beauty	Claytonia caroliniana

	PLANT COMMUNITY
1	Beach dune
2	Oak opening
3	Wet prairie
4	Wet-mesic prairie
5	Delta wetland
6	Mesic sand prairie



Counties of the Lake Erie drainage basin.

Figure 1. Lake Erie-Lake St. Clair Overview

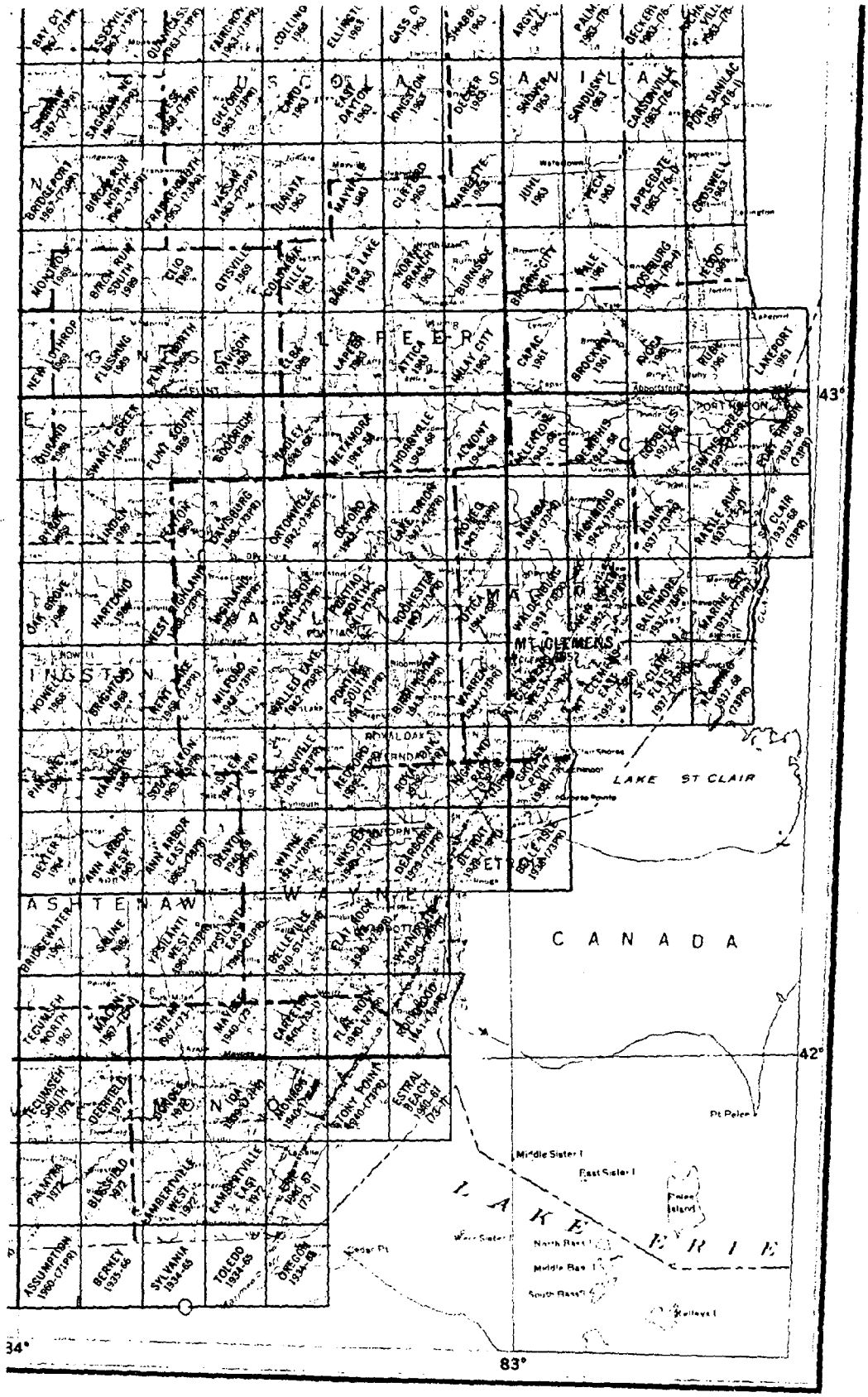


Figure 2. Michigan Topographic Maps (7.5 minute)

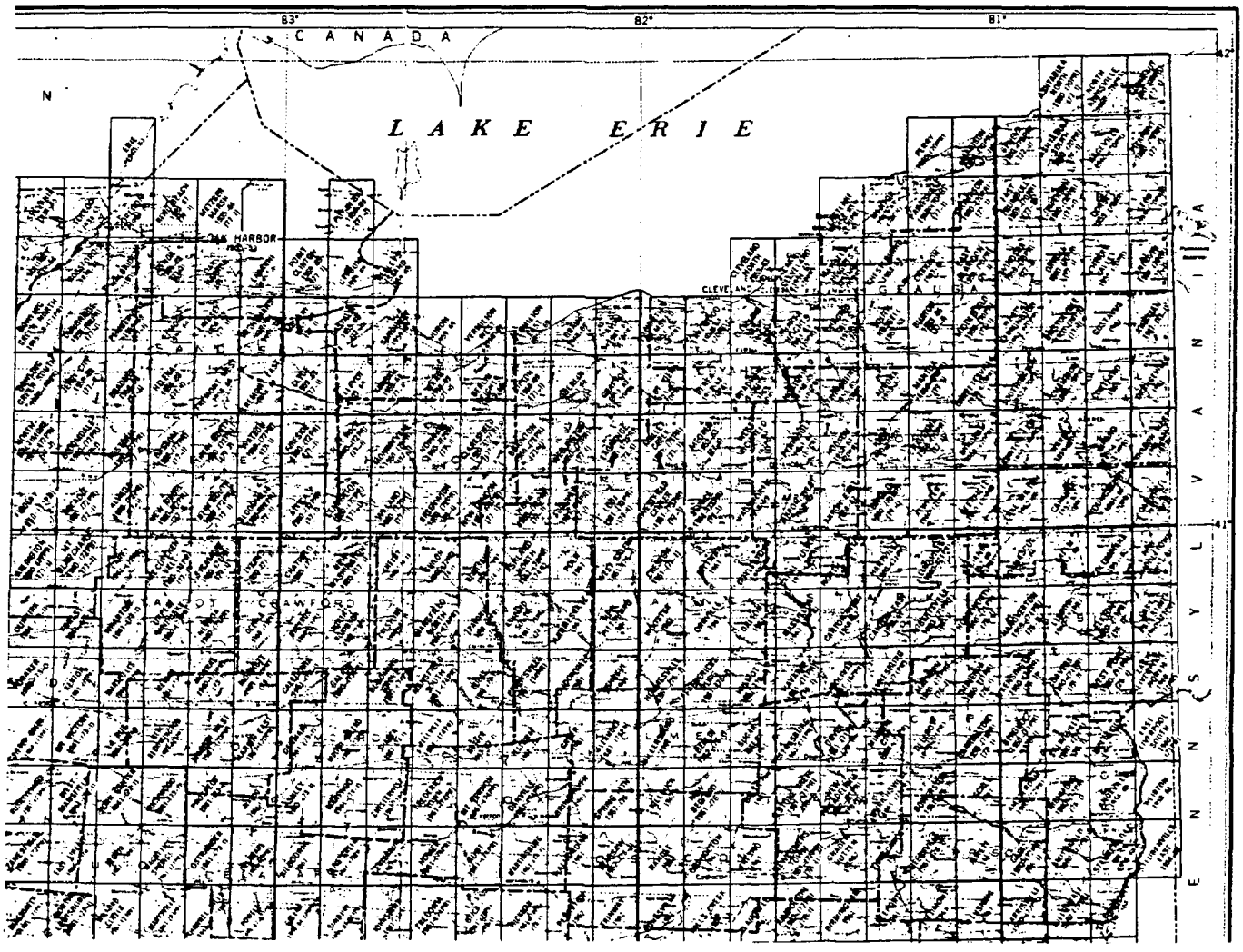


Figure 3. Ohio Topographic Maps (7.5 minute)

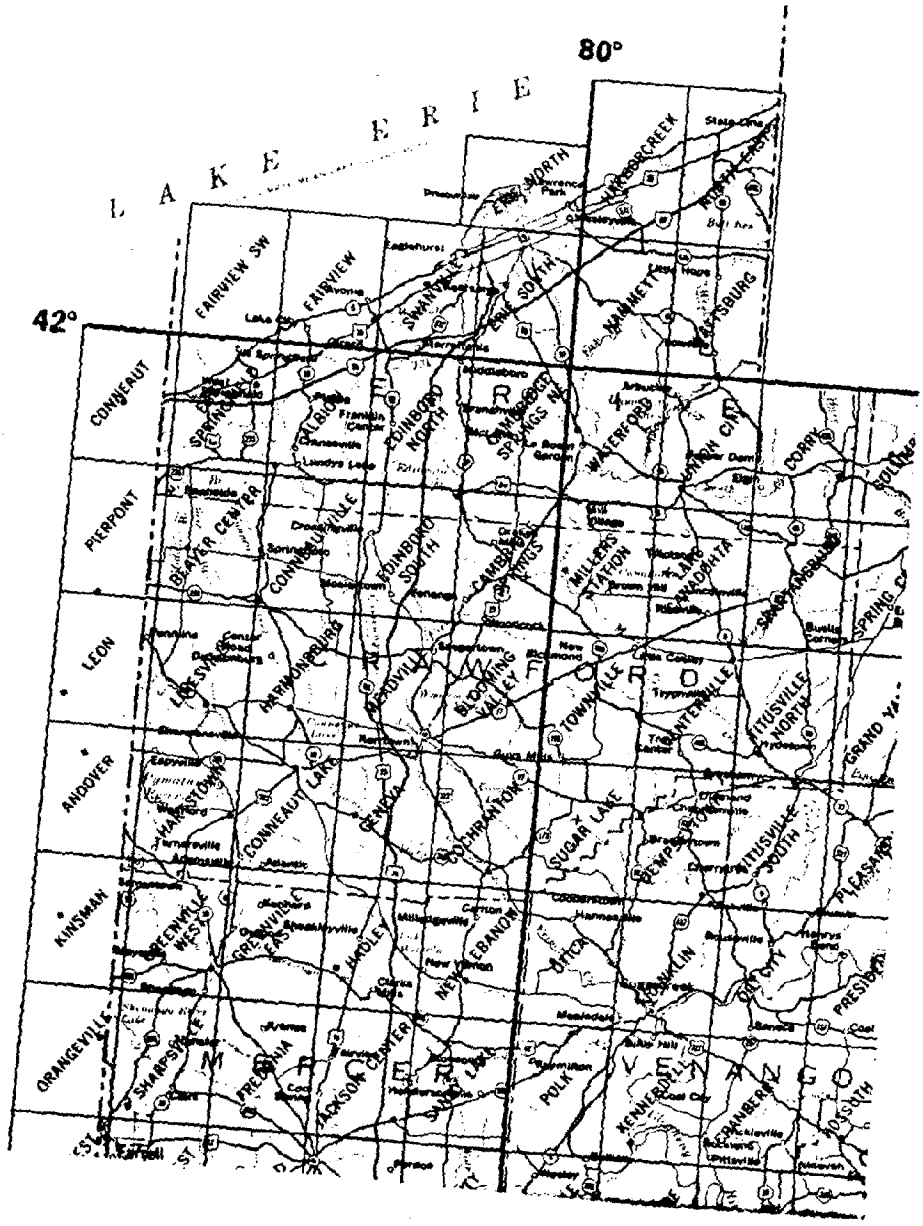


Figure 4. Pennyslyvania Topographic Maps (7.5 minute)

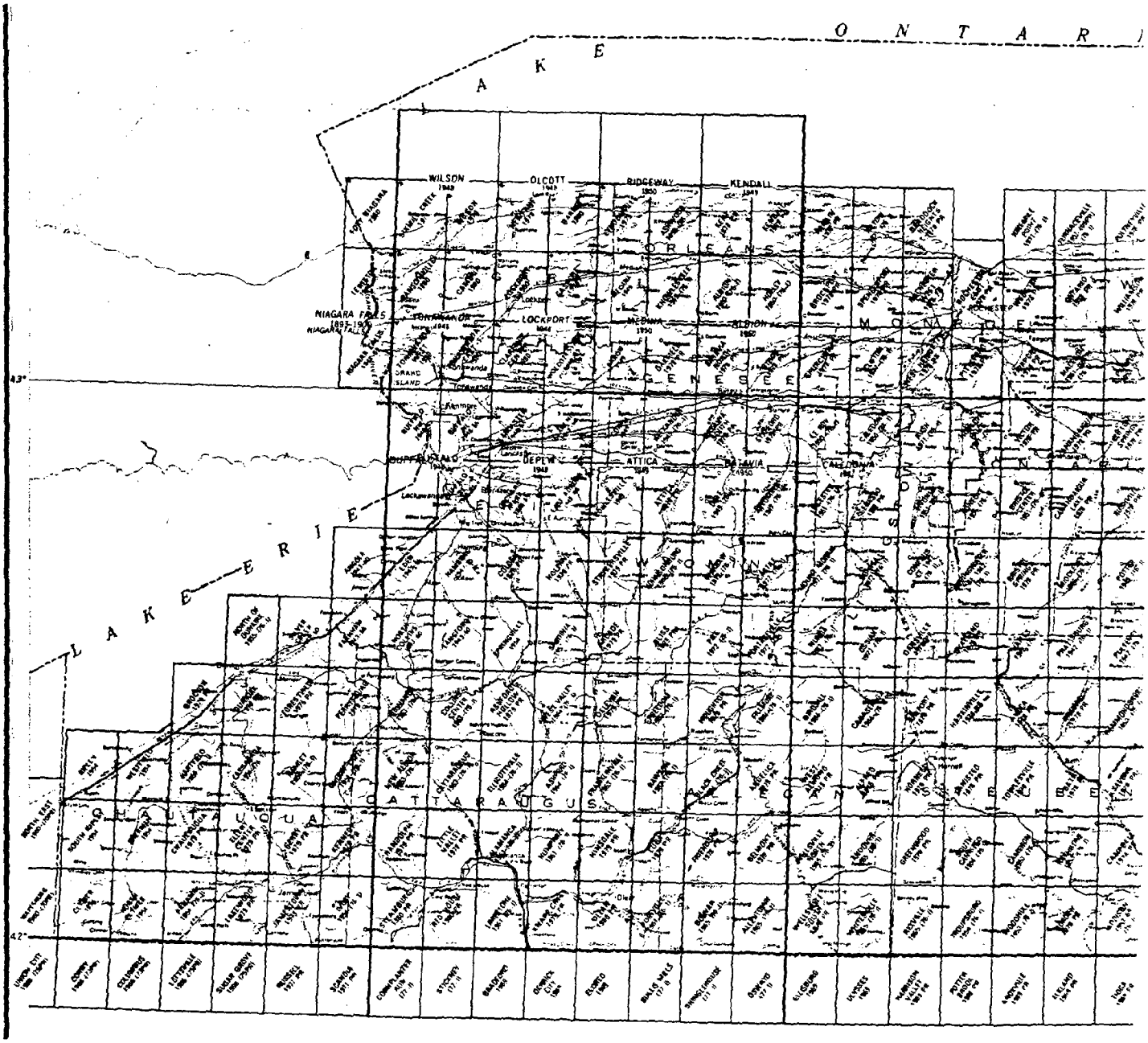


Figure 5. New York Topographic Maps (7.5 minute)

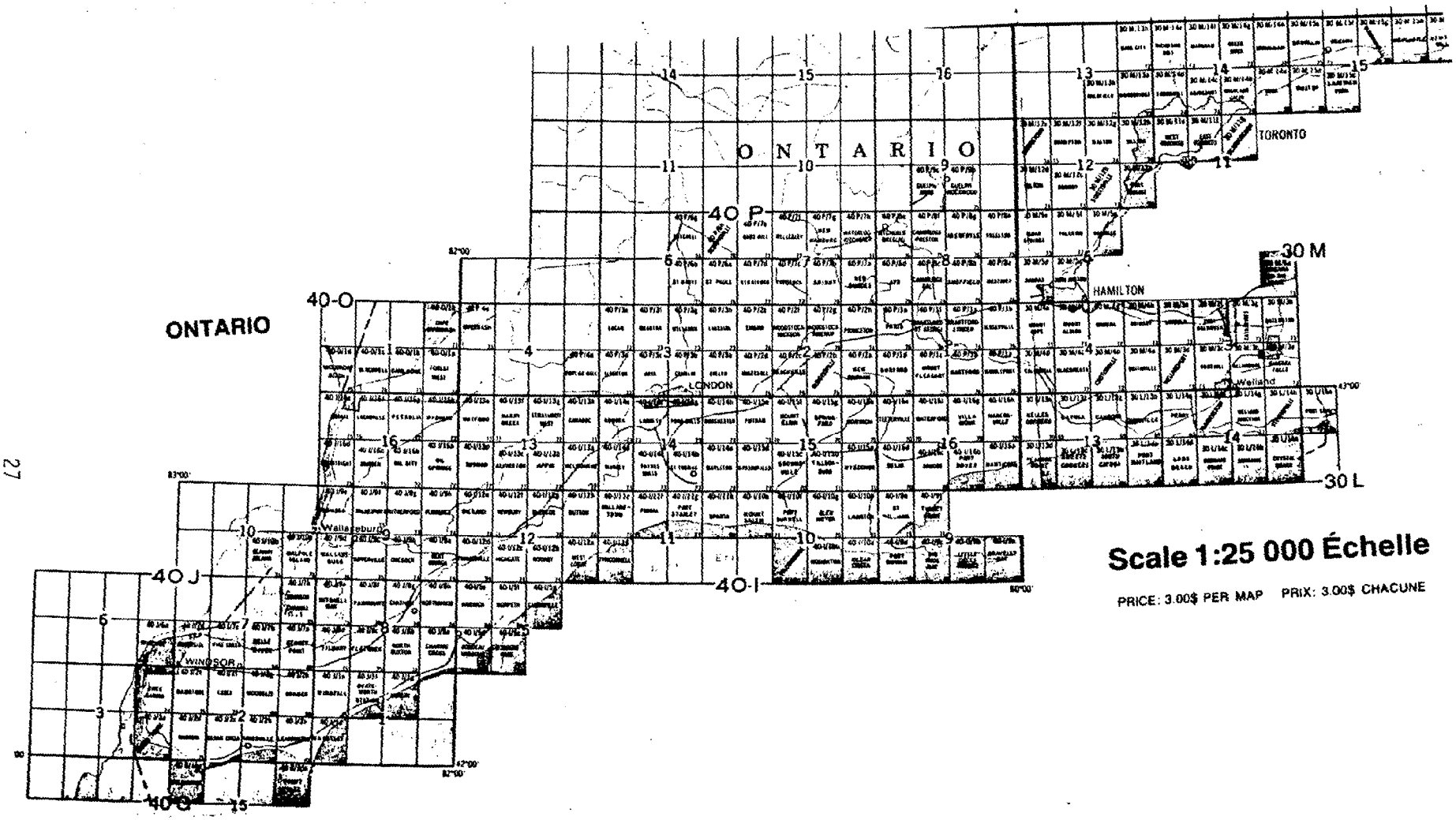


Figure 6. Ontario Topographic Maps (7.5 minute)

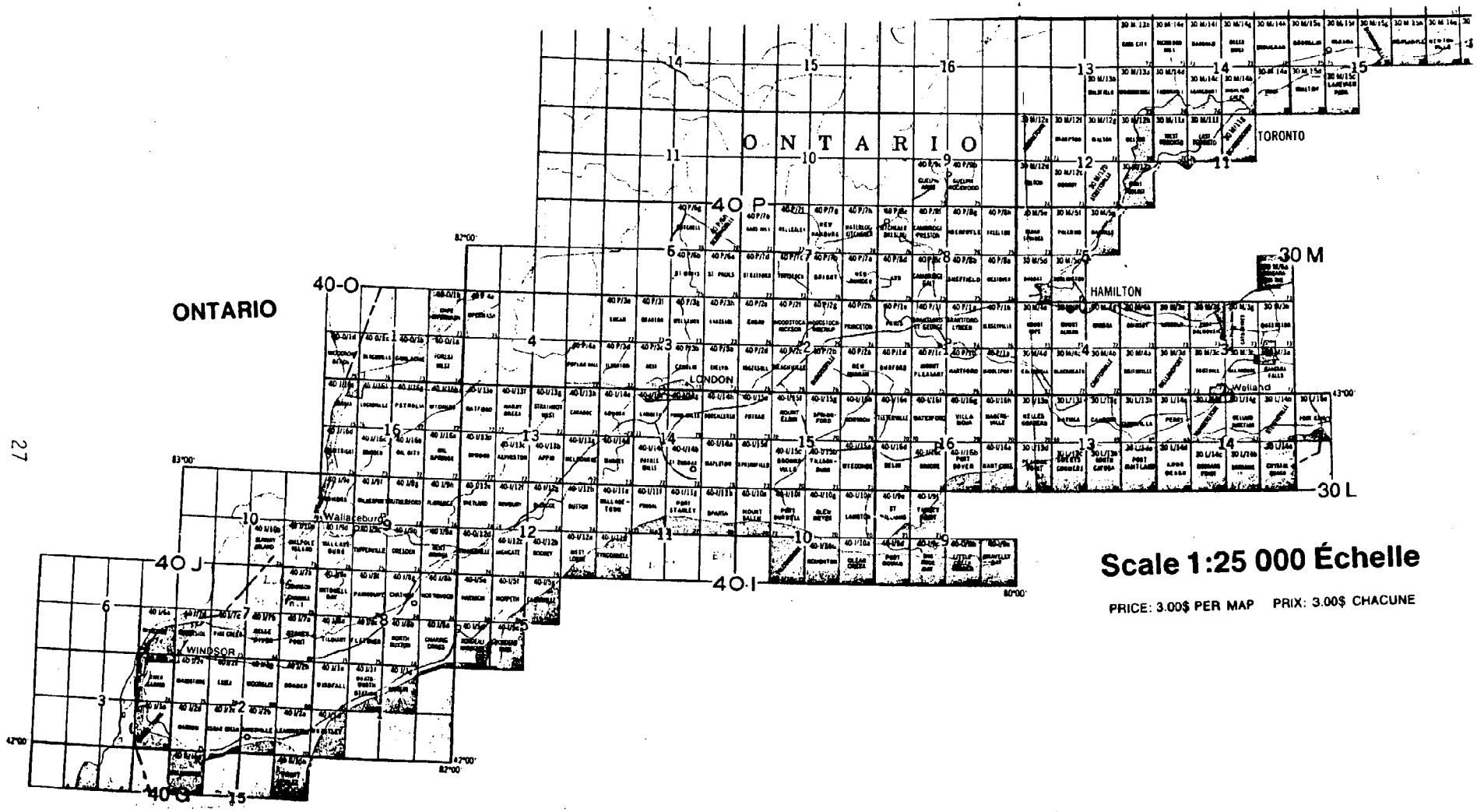


Figure 6. Ontario Topographic Maps (7.5 minute)